Chemical Bonding and Reactions

PS-4 The student will demonstrate an understanding of chemical reactions and the classifications, structures, and properties of chemical compounds.

PS-4.3 Illustrate the fact that ions attract ions of opposite charge from all directions and form crystal lattices.

Taxonomy Level: 2.2-B Understand Conceptual Knowledge

Key Concepts:

Ionic bonds	Ions
Electron transfer	Crystal lattice

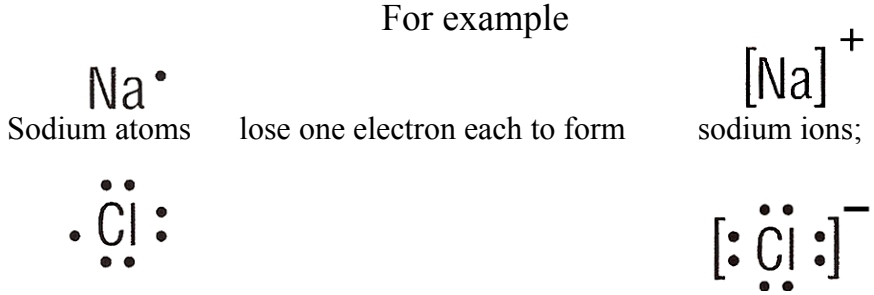
Previous/Future knowledge: In the 7th grade students were introduced to atoms as summarized in indicator 7-4.1. Students have not been previously introduced to the concepts in this indicator. In Physical Science students will explain the concept of ionic bonding and transfer of electrons to become more chemically stable. Ions with opposite electrical charges attract and stick together to form a crystal lattice.

It is essential for students to

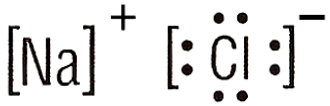
- Understand that metal atoms tend to lose electrons to become stable and that metals in groups 1 and 2 can most easily achieve a stable electron configuration by losing electrons to obtain an electron situation like the closest noble gas. For example:
  - Group 1 metals have one electron in the outer energy level which is one more than the noble gas just before it in the periodic table. Group 1 metals will tend to lose one electron so that its outer energy level becomes stable like the closest noble gas. The atom becomes an ion with a 1+ charge because the number of electrons (-) is now one less than the number of positive protons.
  - Group 2 metals have two electrons in the outer energy level which is two more than the noble gas just before it in the periodic table. Group 2 metals will tend to lose two electrons so that the outer energy level becomes stable like the closest noble gas. The atom becomes an ion with a 2+ charge because the number of electrons (-) is now two less than the number of positive protons.
- Understand that nonmetal atoms tend to gain electrons. For example:
  - Group 16 atoms have two electrons less that the closest noble gas on the periodic table and six electrons in the outside energy level. Group 16 atoms, such as oxygen, become stable by gaining two electrons so that its outer energy level becomes like the closest noble gas. The atom becomes an ion with a 2- charge because it now has two more negative electrons (-) than positive protons.
  - Group 17 atoms have one electron less that the closest noble gas on the periodic table and seven electrons in the outside energy level. Group 17 atoms, such as chlorine, can become stable most easily by gaining one electron so that its outer energy level becomes like the closest noble gas. The atom becomes an ion with a 1- charge because it now has one more negative electron (-) than positive protons.
- Understand that ionic bonds form when positively charged metal ions attract negatively charged nonmetal ions due to the attraction between oppositely charged particles.
  - Positively and negatively charged ions surround each other and pack together as closely as possible to form an ionic crystal.
  - The ions cluster in a ratio that will cancel the net charge of the ions.

- Show examples of ionic crystals or recognize examples of ionic crystals.
  - Examples may be in the form of pictorial diagrams, or verbal descriptions or electron dot formulas.
  - Illustrations of ions should indicate the name and the charge of the ion the illustration represents.
  - Illustrations of crystals must indicate the identity of the ions that compose the crystal and show the ions in a crystal lattice. (PS-2.5)

For example

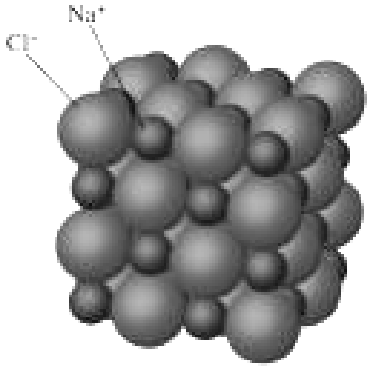


These oppositely charged ions then attract each other in a one to one ratio to form a crystalline arrangement of many ions. Sodium chloride can be represented as follows:



Sodium chloride

or as a Pictorial diagram:



It is not essential for students to

- Predict the types of crystals that ions will form;
- Predict or explain ionic bonding for ionic crystals other than those formed by Groups 1,2,16, and 17 elements unless the charge of the ion is given.

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Assessment Guidelines:

The objective of this indicator is to *illustrate* that ions attract ions of opposite charge from all directions to form crystal lattices, therefore, the primary focus of assessment should be to use diagrams, pictures, or word models to show that positive and negative ions attract each other to form crystals.-

In addition to illustrate, assessments may require students to

- *Classify* substances as ionic crystals;
- *Summarize* the formation of ionic crystals and ions;
- *Compare* the formation of positive and negative ions;
- *Represent* ionically bonded compounds; or
- *Exemplify* positive and negative ions.